Applying the Methods of Evidence Photography to Archaeological Collections

Patrick S. Rivera

ABSTRACT

Forensic photography techniques used to document material criminal evidence can also be applied to the digital documentation and curation of archaeological collections. Combining a computer-operated, drop-out lighting system with standardized principles of composition makes it possible to generate a digital record of historical artifacts that is accurate and consistent across collections. Individuals with minimal background in archaeology or photography can quickly be trained to create publication quality images of historical artifacts. This article explains how to set up a digital photography system for archaeological collections that draws on the methods of forensic evidence photography, as used by the Veterans Curation Program.

Introduction

In 2009 the U.S. Army Corps of Engineers (Army Corps), St. Louis District's Mandatory Center of Expertise for the Curation and Management of Archaeological Collections initiated a novel job training program for American veterans. The Veterans Curation Program (VCP) hires veterans as archaeological laboratory technicians and trains them to rehabilitate and document the extensive cultural resources administered by the Army Corps (Figure 1). Training periods last up to five months, and the majority of the program's graduates go on to find full-time employment.

The veterans who staff the three VCP laboratories are drawn from a variety of military occupational specialties. They have included cable installers who laid network lines at bases in Iraq and Afghanistan, imagery analysts trained to scour satellite images for useful intelligence, and the infantrymen who led missions in combat zones—all of them working in an archaeological setting for the first time. Few have a college degree or professional training in a scientific discipline, and most have never used a camera more elaborate than their smartphone. Creating a high quality digital record of publicly owned archaeological materials is an important part of the VCP's mission. The challenge for the VCP was to develop a system simple enough that every veteran, no matter their previous background or experience, could be trained in a matter of days to take professional, publication quality photographs of historical artifacts. The system would also need to be versatile enough to accommodate the wide range of archaeological materials administered by the Army Corps, and inexpensive enough to be reproduced at multiple facilities.

The VCP was fortunate to be able to draw on the lessons learned by professionals from other fields. Archaeology is not the only discipline specializing in the curation and documentation of material artifacts. Forensics photographers also create digital records of artifacts—artifacts such as bullet casings, weapons, bones, and shoe prints—that are used in judicial proceedings and are subject to heightened scrutiny. In order to generate images that are both admissible and credible in a courtroom environment, law enforcement organizations rely on rigorous photographic protocols that demonstrate consistency, accuracy, and fairness. These protocols are based on standard operating procedures (SOPs) that can quickly and easily be taught to new law enforcement officers who, like many archaeologists, are not fluent in the esoterica of apertures, f-stops, and ISO.

Figure 1. Staff Sergeant Mark Crawford prepares to photograph a ceramic sherd at the Augusta VCP. (Photo by author, 2014.)

The Army Corps St. Louis District's Mandatory Center of Expertise for the Curation and Management of Archaeological Collections partnered with professional evidence photographer David Knoerlein to create a comprehensive digital photography system for federally administered archaeological materials. Knoerlein, president of Forensic Digital Imaging, Inc., and a veteran of the Baltimore Police Department and Broward County, Florida, Sheriff's Office, based the design on the drop-out lighting system he employed during the investigation of mass graves in Iraq. Drop-out lighting systems position a powerful light source beneath an elevated artifact to create the illusion of an object floating in space. In Iraq the system was used to record thousands of images of Kurdish victims and their personal effects, which proved instrumental in Saddam Hussein's conviction for crimes against humanity (Figure 2).

In 2009 the system was reengineered for the three VCP archaeological laboratories using standard commercial hardware and software. Knoerlein and the Army Corps St. Louis District worked closely to develop compositional protocols for broken tea cups and brass buttons rather than exit wounds and skeletal trauma, without sacrificing either image quality or consistency. Since then, the VCP photography system has been used to record more than 10,000 images of historical and prehistoric artifacts representing dozens of federally administered archaeological collections. More than 170 American military veterans have been trained at the VCP to take curation quality photographs of archaeological materials.

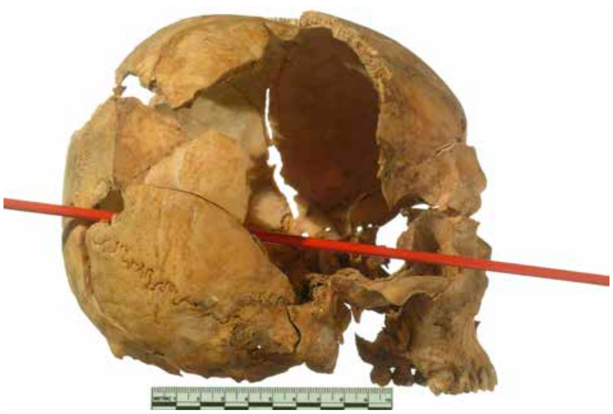

Figure 2. A drop-out lighting photography system was used to record images of evidence from the investigation of crimes against humanity committed during the al-Anfal campaign in Iraq. (Courtesy of the U.S. Army Corps of Engineers Mandatory Center of Expertise for the Curation and Management of Archaeological Collections, St. Louis, MO.)

Specific examples of the resulting digital collections can be viewed at the program's website (<http://www.veteranscurationprogram.org>), along with detailed instructional manuals covering all aspects of operating the photographic system. This article provides an overview of the VCP's drop-out lighting system and photography protocols, information on how to implement a similar system, and a discussion of the benefits in terms of trainability, accuracy, and consistency across large collections.

Preparation and Setup

Materials

The hardware and software described below are suitable for capturing images of artifacts ranging in size from 5 mm (0.2 inches) in diameter, such as beads, to 41 cm (16 inches) in diameter, such as large vessels. Specific equipment models used by the VCP are noted in parentheses. Similar results can be obtained from other camera systems when comparable equipment is used, however.

Camera equipment:

- Digital single lens reflex (DSLR) camera (Canon® T3i)
- Fixed length macro lens (Canon® 60mm f/2.5)
- Live view camera software (Canon® EOS Utility)

Stand equipment:

- Two high power lamps (Impact® studio lamps)
- Counterweighted mono stand (Arkay® 8MS-360)
- Adjustable tripod head (Majestic® Gearhead 1000)
- Plexiglass table or stand (Smith-Victor® TST24 and ST Floor Stand)

Mounting materials

- Plastic metric scales
- Plexiglass sheets
- Rubber erasers and conservator-approved clay and wax

Hardware Setup

Figure 3 shows the physical arrangement of the VCP drop-out lighting system. The powerful light source beneath the plexiglass shooting table creates the "drop-out" effect, which causes artifacts to appear to be floating in a uniform white space. A second light source situated to the left is manipulated to illuminate the exterior of the artifact. The weighted mono stand holds the camera directly over the artifact and allows it to move along vertical and horizontal axes, which is critical for precise focus and composition. The camera is connected to the arm of the mono stand with an adjustable tripod head, which allows the camera lens to face forward, down, or at an angle. The camera needs to be plugged into a power source and connected to the computer with a standard USB cable.

Figure 3. A plexiglass shooting table with a light source beneath it creates the effect of a seamless white background, while the weighted mono stand allows for precise composition and focus. (Photo by author, 2014.)

The camera body needs to be set to autofocus and to aperture priority mode (Av). These settings will allow all important camera functions to be controlled by the computer operator, without the need to adjust buttons on the camera itself. At VCP laboratories a second monitor is connected to the same computer and mounted above the plexiglass table to make it easier to compose photographs.

Software Setup

All Canon DSLR bodies ship with a copy of the Canon EOS Utility software that allows the camera to be controlled and operated from a computer in live view mode. Figure 4 shows the suggested settings for the Canon EOS Utility live view shooting screen. The aperture should be set to *f*/11, although the use of different apertures is discussed below. ISO should be set to 100 to maximize image quality, and image size to large. White balance should be set manually, otherwise images can develop a yellow, green, or red cast. The easiest way to do this is to click on the dropper icon and then click on a white object within the camera's field of view, such as a piece of paper or the white part of a scale. This process can be repeated to recalibrate white balance if it is changed by accident.

Composition Protocols

After the camera software and hardware are installed, the next task is developing a comprehensive protocol for arranging and composing images of each class of artifact to be photographed. Knoerlein (2012) compares a set of expensive cameras and lenses without a composition protocol to "having all the ingredients of a gourmet meal but no recipe." Clear, rigorous protocols are a critical part of making the system easy to reproduce and easy to teach to nonspecialists.

An effective composition protocol designates the number and variety of views required to adequately document an artifact. All artifacts belonging to a particular class will be photographed according to the same standards in order to build absolute consistency across and between collections. In law enforcement, these protocols are referred to as SOPs and they serve to create a uniform photographic record that will resist challenges in judiciary proceedings (Figure 5).

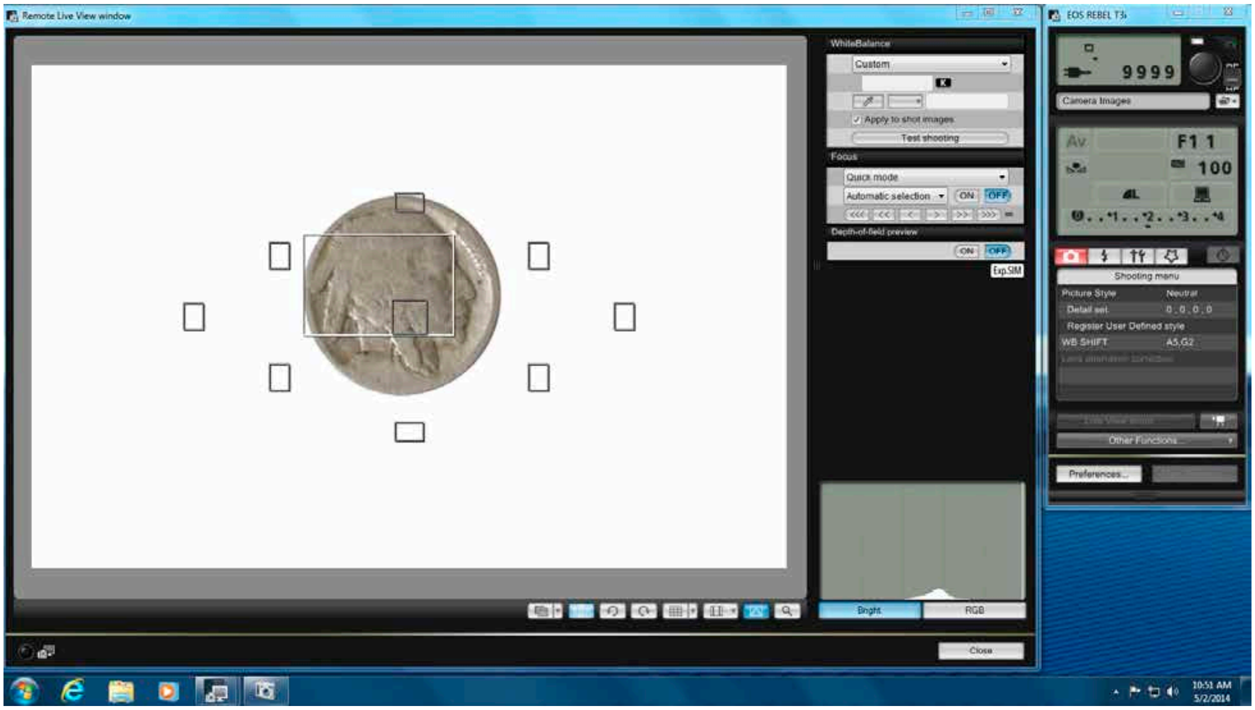

Figure 4. Canon EOS Utility live view software is used to control all camera functions. (Photo by author, 2014.)

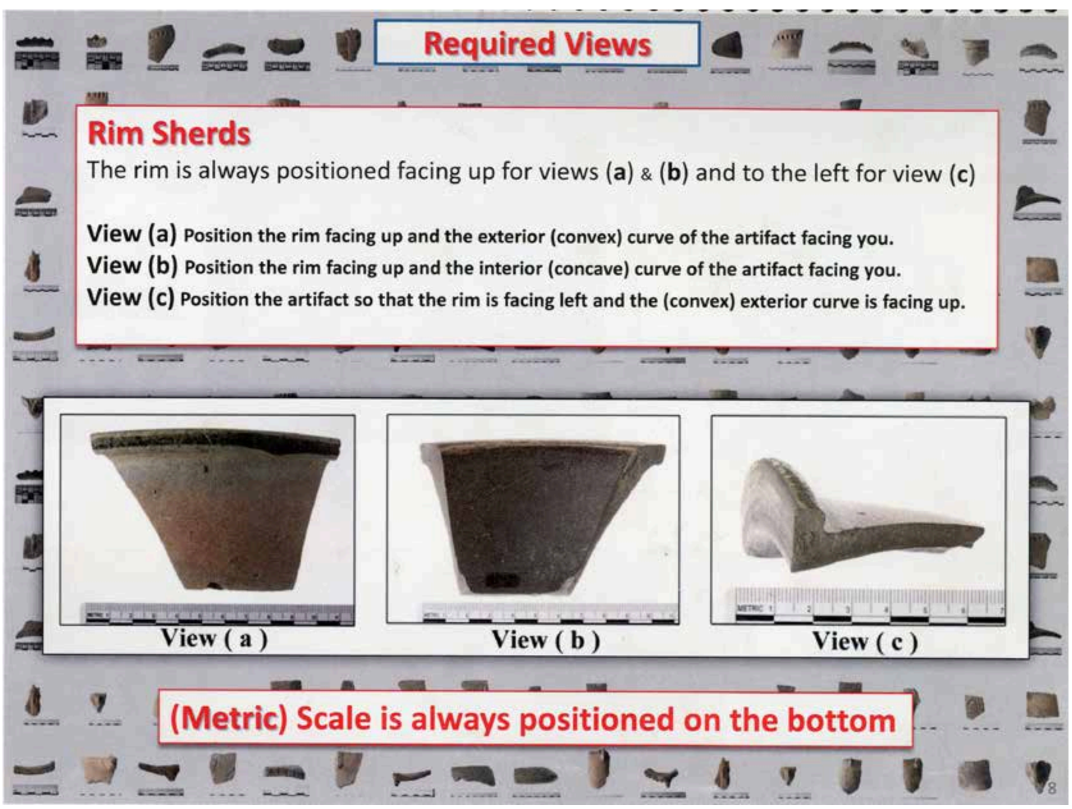

Figure 5. A page from a VCP training manual detailing the composition protocol for rim sherds. Clear operating procedures will produce consistent results (VCP 2014).

The process of developing a composition protocol begins with identifying the different artifact classes and types that will be photographed according to the same conventions. For each class, the following steps should occur:

1. Determine what features of the artifact class need to be recorded (e.g, the shape of ceramic lips, the thickness of sherds, or the width of bottle necks).
2. Decide how many photographic views are necessary to record those features.
3. Decide how the artifact should be oriented and composed in each photographic view.
4. Enumerate the required views and determine an appropriate file naming convention.
5. Add any conditional views as needed, following the same procedure.

In general, veterans at the VCP take at least three photographs of every artifact including an exterior view, an interior or rotated view, and a profile view. Artifacts are oriented toward the top of the screen or the left of the screen. Every image includes a metric scale at the bottom of the photograph for comparative purposes, with the exception of extreme close-ups of features such as engravings and maker's marks. The scale should always be flush with the left-most extremity of the artifact, a convention borrowed from forensic photography where images of evidence such as shoe imprints must be easy to compare with corresponding material artifacts, such as the matching shoe.

The VCP has developed photographic conventions for almost every type of historical and prehistoric artifact based on these principles. Ceramic rim sherds (Figures 6–8) require a minimum of three photographic views including an exterior photograph (A view), interior photograph (B view), and a profile view (C view). A conditional D view photograph is also taken when necessary to show decoration on the lip of the rim. Each view requires the sherd to be oriented in a specific way. By requiring that all rim sherds be photographed according to these same standards, the system generates a collection of images that can easily be compared and navigated. At the same time, veterans with no background in ceramic analysis can easily remember and apply the protocols.

Metal coins (Figures 9, 10) are another common artifact at historical excavations. At the VCP, coins are photo-

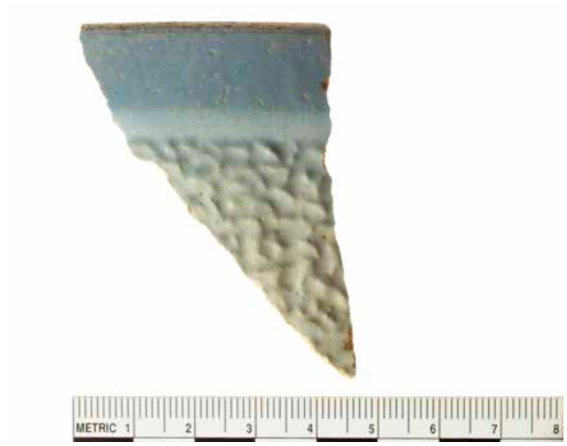

Figure 6. Exterior view of a rim sherd (A view) photographed according to VCP conventions. The rim is parallel with the top of the screen. (Photo by author, 2014.)

Figure 7. Interior view of a rim sherd (B view) photographed according to VCP conventions. (Photo by author, 2014.)

Figure 8. Profile view of a rim sherd (C view) photographed according to VCP conventions. The rim faces the left side of the screen, and the exterior surface faces the top. (Photo by author, 2014.)

Figure 9. Obverse view (A view) of a coin. Details of writing and design are emphasized by manipulating the angle of light on the surface. (Photo by Mark Crawford, 2014.)

Figure 10. Reverse view (B view) of a coin. (Photo by Mark Crawford, 2014.)

graphed from two views, the obverse (A view) and the reverse (B view). The coin is oriented so that any portrait or image is facing up. Coin faces without images are oriented so as much of the inscription is legible as possible. A profile photograph (C view) is conditional for coins, because many coins are so thin that mounting them vertically requires the use of extremely sticky wax that can damage delicate patinas or oxidization.

Coins and ceramic rims are only two examples of the sorts of artifacts that historical archaeologists encounter. These same compositional principles can be adapted to any sort of material object, however, keeping in mind the mantra, the clearer the protocols are, the more consistent the result.

Imaging Methodology

The VCP drop-out lighting system relies on live view software to operate the camera and capture images. Artifacts are mounted onto clear plexiglass sheets, the camera is manipulated on the mono stand until the correct composition is achieved, lighting is changed, and the computer operator captures and evaluates the image. The basic workflow can be broken down into the following recommended steps.

1. Elevate and mount the artifact at least 1 cm (0.4 inches) over a plexiglass surface using modeling clay, sticky wax, or an eraser piece (Figures 11, 12). Elevating artifacts above a strongly lit background

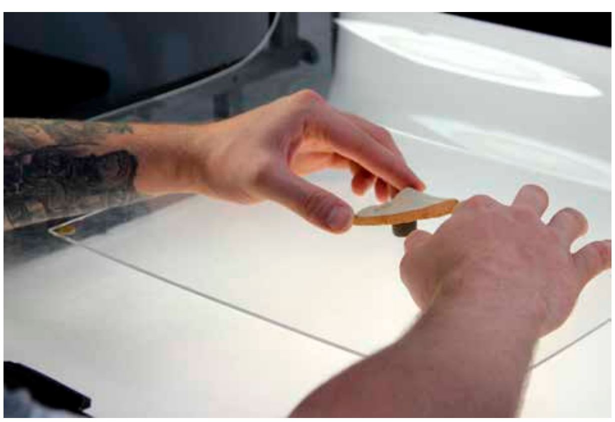

Figure 11. Staff Sergeant Mark Crawford mounts a ceramic sherd onto a plexiglass sheet using nonreactive modeling clay. (Photo by author, 2014.)

Figure 12. Nonreactive modeling clay can be formed into a pedestal that will support most artifacts. (Photo by author, 2014.)

is the foundation of a drop-out lighting system. Because of the nature of lens optics, any dust, dirt, and scratches outside the plane of focus will become blurred and merge into the white background, yielding a uniform white surface behind every artifact. Clay, wax, and eraser pieces can be used to mount and elevate artifacts. Clay is generally the most versatile mounting substance, though wax provides a stronger hold that can be especially useful for mounting tiny or unbalanced artifacts. Special care must be taken when mounting heavily patinated or oxidized artifacts such as rusty nails or bronze buttons. Sticky mounting substances, especially wax, can easily adhere to and tear off patinas. To minimize potential damage, wax should never be used when mounting these artifacts.

2. Center the camera over the artifact and raise or lower it until the artifact fills the screen, leaving enough room at the bottom of the image to fit the metric scale.
3. Elevate the scale to the same height as the surface of the artifact, and line it up with the artifact's left-most extremity (Figure 13).
4. Focus on the desired surface starting with autofocus and fine-tuning with manual focus. Perfect focus can be achieved through a combination of automatic and manual functions. The "quick mode" focus button in the Canon EOS Utility is usually sufficient for accurate focus, but the operator can also use the zoom function and the focus arrows to fine-tune which part of the artifact is in focus (Figure 14). One setting that plays an especially important role in appropriate focus is the size of the aperture through which light enters the camera. At the VCP, *f*/11 is the default aperture size since it achieves a high level of sharpness and a useful depth of field. Apertures as small as *f*/32 are used in special cases where the increased depth of field is considered more important than absolute sharpness.
5. Adjust the overhead lighting to provide appropriate coverage and contrast. After the artifact is mounted and focus is achieved, the secondary light source is manipulated. Appropriate lighting can increase contrast in the image and emphasize patterns and marks on the exterior of the artifact. A lower and more horizontal lighting source can bring out details of texture, especially on nonreflective or matte surfaces. A higher, more vertical light source is often effective for photographing reflective surfaces such as glass and metal. Clear glass and white artifacts present special challenges for a drop-out lighting system because they have a tendency to merge into the white background (Figures 15, 16). When photographing these artifacts it can be helpful to elevate the light source to minimize reflective glare. Some postprocessing of the image may be necessary to increase contrast between the background and the artifact. The "color enhancement" tool on Microsoft

Figure 13. A metric scale is elevated to the same height as the surface of the artifact and positioned flush left for easy measurement. (Photo by author, 2014.)

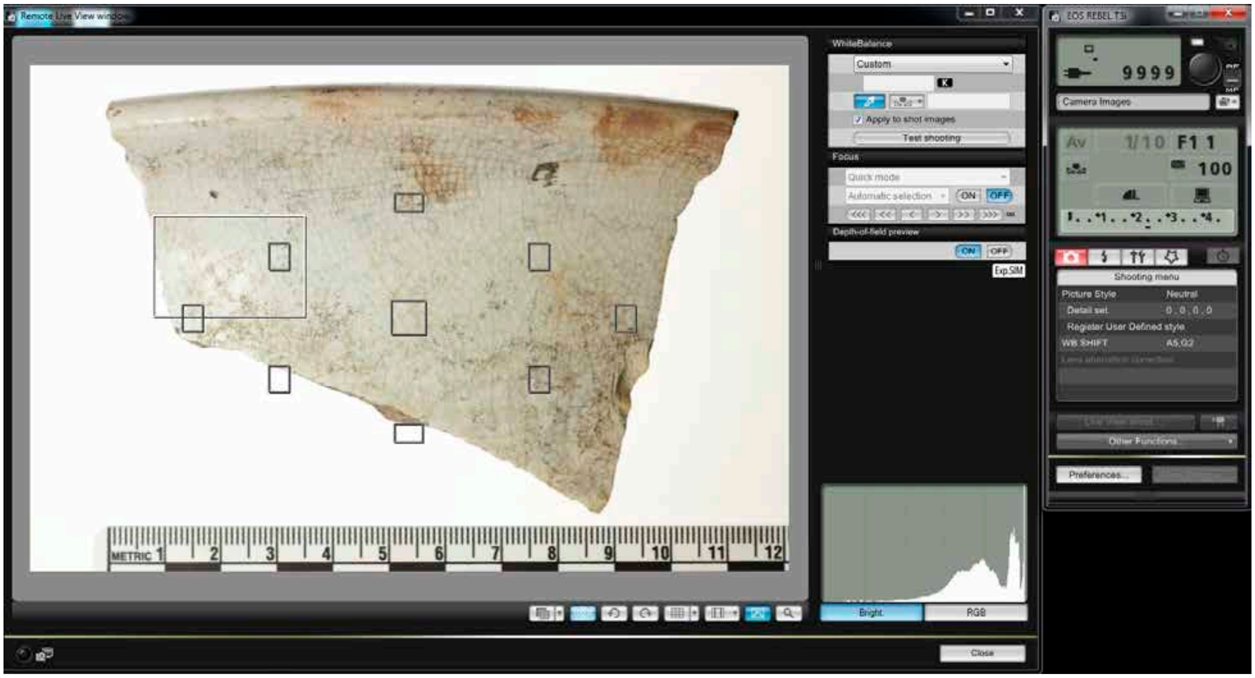

Figure 14. The "quick mode" focus button usually provides accurate focus. (Photo by author, 2014.)

Figure 15. Raising the exterior light source makes it easier to see this pipe stem against the white background. (Photo by author, 2014.)

Figure 16. Changing the angle of the exterior light can minimize glare on clear artifacts. (Photo by author, 2014.)

Office Picture Manager can perform this function when applied to the background of the image. The use of postprocessing software should be clearly addressed in composition protocols.

6. Adjust the exposure value if the image is too dark or too light.
7. Capture the photograph. Repeat with variations in lighting and exposure as necessary. After the first photograph is taken, multiple images can be captured while the artifact is still mounted by varying the light source and the exposure. These should be compared to select the one that best represents the artifact.
8. Perform quality control review, rename the images, and move into secure storage. At this stage, images should be carefully checked for basic flaws such as imperfect focus, misaligned scales, or visible dust and scratches beneath the artifact. Images that pass this basic quality control review can be renamed according to the appropriate convention and transferred to storage (Figure 17). Images that have passed preliminary quality control reviews should be

Figure 17. Photographs that are accurately composed, appropriately lit, and free from flaws including visible dust or scratches can be moved into storage. (Photo by author, 2014.)

stored securely and backed-up on a separate drive or storage medium. No further postprocessing should be applied to these archival images. At the VCP, a single individual performs quality control reviews on all images to maintain consistency and uniformity.

A visual guide to the entire photographic process is available for free at the program's website (<http://www.veteranscurationprogram.org/training/>).

Conclusion

Applying forensics methods to the digital photography of artifact collections has clear benefits in terms of accuracy, consistency, and trainability. Photographing artifacts with a drop-out lighting system and live view software creates high quality images that are appropriate for professional and academic publications as well as public use. The application of standardized composition protocols makes images of artifacts consistent across and between collections (Figure 18), and makes it easy to train nonspecialists to take useful digital photographs of historical artifacts. At the VCP laboratories, more than 170 American veterans have learned to take publication quality photographs of archaeological resources with less than a week of training each. This forensics-based system has standardized the digital curation of hundreds of archaeological collections administered by the Army Corps, and it provides another useful tool for archaeological professionals to employ as they seek to document, record, and preserve the past.

Figure 18. The images that result from a forensic-based approach to photography make it easier to navigate and compare large artifact collections. (Courtesy of David Knoerlein, 2014.)

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Patrick S. Rivera
Veterans Curation Program
3830 Washington Road, Ste. 27
Augusta, GA 30907
privera@newsouthassoc.com